ORIGINAL ARTICLE

Bacteremic Melioidosis in Southern Taiwan: Clinical Characteristics and Outcome

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Background/Purpose: In recent years, the number of cases of melioidosis has increased substantially in Taiwan. However, there have been no publications specifically studying patients who have bacteremic melioidosis in Taiwan. This study aimed to determine the clinical characteristics and outcome of patients with bacteremic melioidosis in Taiwan.

Methods: We retrospectively reviewed the records of 30 patients (mean age, 65 years) with blood culture-confirmed melioidosis who were managed at Tainan Municipal Hospital between June 2004 and January 2007. Nineteen out of 30 patients were identified within 1 month after Typhoon Haitang struck in mid-July 2005. A comparison of demographic characteristics, underlying conditions, biochemistry results, and clinical presentations between survivors ($n=21$) and non-survivors ($n=9$) was analyzed.

Results: Underlying conditions were identified in 90% of patients, diabetes mellitus being the commonest (50%). The most common site of infection was the lung (70%), followed by the genitourinary tract (13.3%), peritoneum (6.7%), meninges (3.3%), skin (3.3%), and aorta (3.3%). There were also 20% of cases without a primary site of infection being identified. Twenty percent of patients had multiple sites of infection. The number of bacteremic melioidosis with pneumonia was significantly higher in the post-typhoon outbreak ($p=0.001$). Comparing survivors and non-survivors, there were no significant differences in age, gender, underlying conditions, and presence of pneumonia. Significant differences were evident in elevated serum creatinine ($p=0.038$) and pH ($p=0.004$). Fifty-six percent (5/9) of deaths occurred within 48 hours after presentation to hospital and 67% (6/9) of deaths occurred in the post-typhoon outbreak. Patients with septic shock ($p<0.001$), acute renal failure ($p=0.013$), and respiratory failure ($p=0.001$) had significantly higher mortality. The in-hospital mortality rate was 27% and the relapse rate was 14%.

Conclusion: The lungs were the most common site of infection in patients with bacteremic melioidosis and rapidly progressive community-acquired pneumonia (CAP) was the major cause leading to mortality. Patients with septic shock, acute renal failure, and acute respiratory failure had a much higher mortality rate. Typhoon Haitang was associated not only with higher numbers of cases and deaths but also with pneumonic presentations. Locally adapted guidelines need to be developed for the treatment of CAP in an endemic area of melioidosis in southern Taiwan and after extreme weather events such as typhoons or heavy rains. [*J Formos Med Assoc* 2007;106(12):1013–1022]

Key Words: bacteremic melioidosis, *Burkholderia pseudomallei*, community-acquired pneumonia, Taiwan, typhoon

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Melioidosis is an infectious disease caused by the facultative intracellular Gram-negative bacterium *Burkholderia pseudomallei*. The pathogen is widely distributed in pooled surface water and mud in the tropics, mainly between the latitudes of 20° North and 20° South.[1] Prominent endemic areas include Southeast Asia and northern Australia. Although Taiwan (between the latitudes of 22° and 25° North) is geographically close to this endemic area, melioidosis has been reported in the country only sporadically.[2–11] However, in recent years, the number of sporadic cases has increased substantially in Taiwan. From 2001 to 2005, there were 118 cases of *B. pseudomallei* infections confirmed by the Taiwan Centers for Disease Control.[12] The majority (104 cases, 88%) resided in southern Taiwan, located between latitudes 22° and 23° North. An outbreak of melioidosis cases developed after Typhoon Haitang in southern Taiwan from July 2005 to September 2005.[13] Southern Taiwan can therefore be regarded as an endemic area.

Clinical manifestations of melioidosis range from an acute fulminant septicemia to a chronic debilitating localized infection. Acute melioidosis, especially when bacteremic, is life-threatening, and necessitates early diagnosis and appropriate antibiotic treatment to circumvent mortality. In Taiwan, there have been no publications specifically studying the subgroups of patients who have bacteremic melioidosis. To elucidate the clinical characteristics and outcome of this disease in Taiwan, we retrospectively reviewed the records of patients with blood culture-proven melioidosis who were managed at Tainan Municipal Hospital between June 2004 and January 2007. The findings of this review are presented in this report.

Methods

Patient selection

Tainan Municipal Hospital is a 630-bed referral teaching hospital located in Tainan City, Taiwan. The hospital receives patients mainly from Tainan City, southern Tainan county, and northern Kaohsiung county in southern Taiwan. All patients admitted to the hospital during the period from June 2004 to January 2007 with positive blood cultures for *B. pseudomallei* were included in this study. *B. pseudomallei* was identified by conventional biochemical methods and confirmed by the API 20NE identification system (BioMérieux, Marcy-I'Etoile, France). All cases were confirmed by the Taiwan Centers for Disease Control.

Definite diagnoses of urinary tract infection, peritonitis, meningitis, and skin abscess were achieved by isolating *B. pseudomallei* from urine, ascites, cerebrospinal fluid, and skin abscess, respectively. Patients were followed up after hospital discharge on an outpatient basis. The duration of follow-up ranged from 3 to 32 months.

Data collection

Data collected on patients included demographic characteristics, underlying conditions, biochemistry results, radiographic data, antimicrobial treatment, and outcomes. The data on monthly total rainfall in the Tainan area were provided by the Central Weather Bureau, Taiwan (www.cwb.gov.tw/V5/index.htm).

Definitions

Pneumonia was diagnosed when the patient had clinical and chest radiographic evidence of pneumonia. Chronic renal disease was defined as a serum creatinine level > 177 μmol/L (normal, < 133 μmol/L) occurring before melioidosis. Excessive alcohol consumption was defined as more than two drinks (20 g) per day in women and more than three drinks (30 g) in men. Coronary heart disease was defined as > 50% luminal narrowing of a coronary artery on coronary angiography. Cerebrovascular disease was manifested either as brain infarction or hemorrhage. Septic shock was defined as sepsis with a systolic blood pressure ≤ 90 mmHg despite adequate fluid resuscitation. Acute renal failure was defined as a reduction in the estimated creatinine clearance of 50% relative to the value on admission, or a decline in renal function that resulted in the need for renal replacement therapy. Respiratory failure was defined as arterial carbon dioxide > 45 mmHg or arterial

oxygen tension (PaO_2) < 55 mmHg when the fraction of oxygen in inspired air (FIO_2) ≥ 0.6. The need for intensive care unit (ICU) admission was defined by using an American Thoracic Society rule that requires the presence of either one of two major criteria (need for mechanical ventilation or septic shock) or two of three minor criteria (systolic blood pressure ≤ 90 mmHg, multilobar disease, PaO_2/FIO_2 ratio < 250).[14] Appropriate empiric antibiotic therapy was defined as the ongoing use of antibiotics (imipenem, meropenem, ceftazidime, TMP-SMX, doxycycline, amoxicillin-clavulanic acid) with clinical activity against *B. pseudomallei* at the time of microbiologic confirmation.

Statistical analysis

Statistical tests were performed with SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). The Mann–Whitney *U* test was used for comparisons of continuous variables between survivors and non-survivors. Categorical variables were compared using χ^2 test or Fisher's exact test. A difference with a two-tailed *p* value of less than 0.05 was regarded as statistically significant.

Results

Patient characteristics

During the 32-month period, there were 37 patients admitted to Tainan Municipal Hospital with melioidosis. A total of 30 (81.1%) patients with bacteremic melioidosis were included in the study. Figure 1 shows the geographic distribution of their residences, including South District (*n* = 7, 23.3%) in Tainan City, Rende Township (*n* = 9, 30%) in Tainan County, and Jiading Township (*n* = 13, 43.3%) and Hunei Township (*n* = 1, 3.3%) in Kaohsiung County. All patients resided in the aforementioned affected regions located between latitudes 22° and 23° North. There were 20 men (66.7%) and 10 women (33.3%). Mean age was 65.2 ± 13.9 years (range, 38–87 years). Figure 2 shows the age distribution. This disease occurred in all age groups above 30 years old. The peak incidence was in the fifth, sixth and seventh decades. No history of traveling to Southeast Asia or northern Australia could be traced in 27 patients (90%). Twenty-two patients (73%) did not have a history of exposure to wet soil or contaminated water approximately 1 week prior to the onset of symptoms. Only one patient (3.3%) was a rice farmer with soil exposure.

Twenty-seven patients (90%) had underlying conditions, including diabetes mellitus (*n* = 15, 50%), chronic renal disease (*n* = 6, 20%), excessive alcohol consumption (*n* = 6, 20%), malignancies (*n* = 4, 13.3%), hypertension (*n* = 11, 36.7%), coronary heart disease (*n* = 8, 26.7%), cerebrovascular disease (*n* = 6, 20%), and liver cirrhosis (*n* = 4, 13.3%). Twenty patients (66.7%) had more than one underlying condition.

The most common site of infection was the lung (*n* = 21, 70%), followed by the genitourinary tract (*n* = 4, 13.3%), peritoneum (*n* = 2, 6.7%), meninges (*n* = 1, 3.3%), skin (*n* = 1, 3.3%), and aorta (*n* = 1, 3.3%). There were also 20% (*n* = 6) of cases in whom the primary site of infection was not detected. Six patients (20%) had multiple sites of infection. Of these, both the lung and urinary tract were involved in four patients (13.3%), both the lung and meninges were involved in one patient (3.3%), and both the lung and peritoneum were involved in one patient (3.3%). Twenty-seven patients (90%) were febrile and three patients (10%) were afebrile at the time of admission. Of the latter three patients, one patient was admitted for a survey of lung tumor, one patient was admitted due to intracranial hemorrhage, and one patient was admitted because of cerebral infarction. Fever developed in these three patients on the 5th, 5th, and 7th hospital day, respectively. Blood cultures collected from these patients on the day of fever grew *B. pseudomallei*, at which time the diagnosis of melioidosis was made.

Overall, 13 patients (43.3%) had septic shock, 16 patients (53.3%) had respiratory failure, and 19 patients (63.3%) had acute renal failure. Fourteen patients (46.7%) required admission to the ICU, including 13 with acute respiratory failure and nine with septic shock. The median length of stay in the ICU was 7 days (range, 1–21 days).

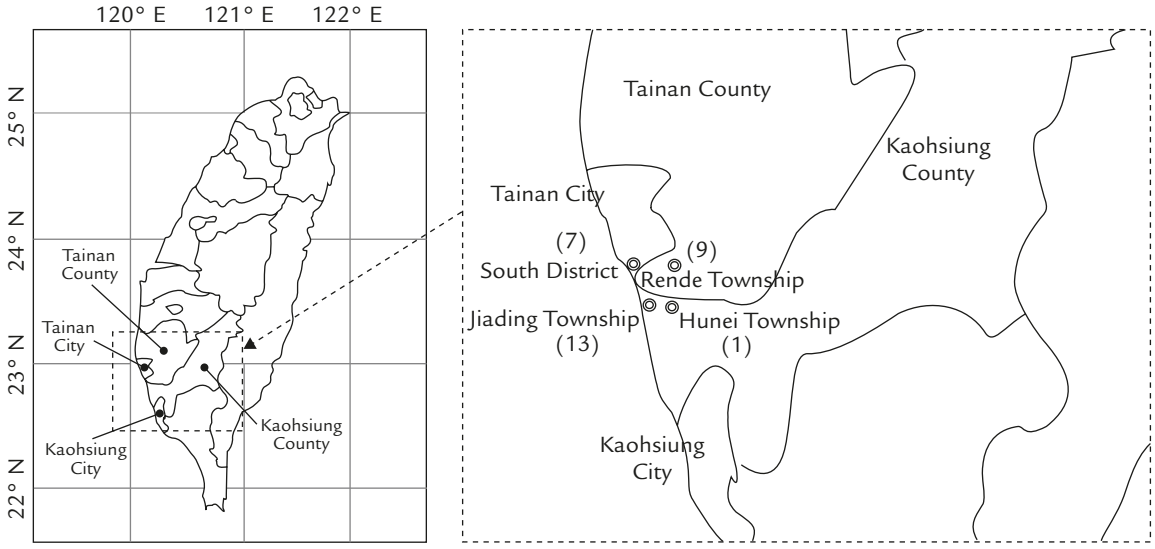

Figure 1. Map of Taiwan, showing the geographic distribution of the affected areas.

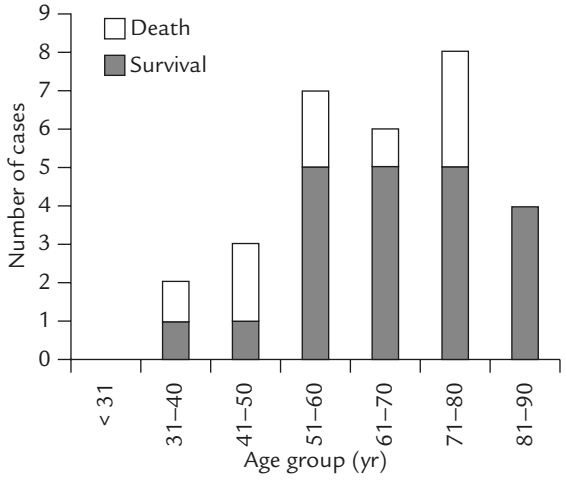

Figure 2. Number of cases of bacteremic melioidosis according to different age groups.

The median acute physiology and chronic health evaluation II score was 29 (range, 11–36). The mean length of hospital stay was 18.4 ± 11.2 days (range, 0–47 days). Twenty-two patients (73%) received appropriate empiric antibiotic therapy.

Comparison of survivors and non-survivors

A comparison of demographic data, underlying conditions, biochemistry data, and clinical presentations between survivors and non-survivors is summarized in Table 1. There were no significant differences in age, gender, underlying condition, or presence of pneumonia between survivors and non-survivors. However, there were significant differences in serum creatinine ($p = 0.038$) and pH ($p = 0.004$). Patients with septic shock (odds ratio [OR], 73.89; 95% confidence interval [CI], 9.45–577.91; $p < 0.001$), acute renal failure (OR, 17.35; 95% CI, 1.91–157.48; $p = 0.013$), and respiratory failure (OR, 36.73; 95% CI, 4.47–301.69; $p = 0.001$) had significantly higher mortality. Non-survivors had significantly shorter length of hospital stay ($p = 0.017$).

Figure 3 shows the correlation between the number of survivors or non-survivors and monthly total rainfall in the Tainan area during the 32-month period. Twenty-four patients (80%) were admitted during the 3 months of the rainy season (June, July, August) annually. Peak incidence was noted in July 2005. A total of 19 patients (63%) suffered from bacteremic melioidosis within 1 month after Typhoon Haitang (55.0 m/sec of maximal wind speed) struck in mid-July 2005. Six deaths (67%) occurred in this post-typhoon outbreak. The number of cases of bacteremic melioidosis with pneumonia was significantly higher in this post-typhoon outbreak (OR, 34; 95% CI, 3.25–355.41; $p = 0.001$).

Outcomes

The clinical manifestations and hospital length of stay of nine deaths are shown in Table 2. One

Table 1. Comparison of characteristics between survivors and non-survivors*

	Total ($n=30$)	Survivors ($n=21$)	Non-survivors ($n=9$)	p
Age (yr)	65.2 ± 13.9	67.0 ± 13.9	60.9 ± 13.9	0.248
Gender (M/F)	20/10	14/7	6/3	1.000
Underlying condition				
DM	15 (50)	10 (47.6)	5 (55.6)	1.000
Chronic renal disease	6 (20)	5 (23.8)	1 (11.1)	0.637
Excessive alcohol consumption	6 (20)	5 (23.8)	1 (11.1)	0.393
Malignancy	4 (13.3)	1 (4.8)	3 (33.3)	0.069
Hypertension	11 (36.7)	9 (42.9)	2 (22.2)	0.675
CHD	8 (26.7)	8 (38.1)	0	0.067
CVD	6 (20)	6 (28.6)	0	0.141
Liver cirrhosis	4 (13.3)	2 (9.5)	2 (22.2)	0.143
Biochemistry data†				
WBC (10^9/L)	17.58 ± 10.28	17.58 ± 8.36	17.58 ± 14.44	0.734
Platelets (10^9/L)	178.20 ± 125.17	204.80 ± 135.16	116.12 ± 70.22	0.094
BUN (μmol/L)	47.37 ± 33.49	13.27 ± 7.31	25.01 ± 16.32	0.099
Creatinine (μmol/L)	249.02 ± 184.07	228.07 ± 202.49	295.61 ± 132.90	0.038
CRP (mg/dL)	19.55 ± 12.65	17.29 ± 10.95	25.94 ± 15.91	0.234
Sodium (mmol/L)	128.15 ± 7.48	129.22 ± 6.60	125.90 ± 9.07	0.431
Potassium (mmol/L)	4.28 ± 0.93	4.11 ± 0.69	4.66 ± 1.28	0.239
pH	7.32 ± 0.16	7.40 ± 0.09	7.21 ± 0.18	0.004
$PaCO_2$ (mmHg)	31.20 ± 10.70	28.52 ± 9.75	34.78 ± 11.42	0.256
Bicarbonate (mmol/L)	16.12 ± 6.86	18.08 ± 8.02	13.52 ± 3.99	0.213
Pneumonia	21 (70)	14 (66.7)	7 (77.8)	0.681
Septic shock	13 (43.3)	4 (19.0)	9 (100)	< 0.001
Respiratory failure	16 (53.3)	7 (33.3)	9 (100)	0.001
Acute renal failure	19 (63.3)	10 (47.6)	9 (100)	0.013
Hospital LOS (d)	18.4 ± 11.2	10.8 ± 4.8	3.7 ± 3.6	0.017

**Data are presented as mean ± standard deviation or n (%) of patients; †samples collected on taking blood culture. DM = diabetes mellitus; CHD = coronary heart disease; CVD = cerebrovascular disease; WBC = white blood cell count; BUN = blood urea nitrogen; CRP = C-reactive protein; LOS = length of stay.*

patient was dead on arrival in the emergency room and eight patients died during hospitalization, representing an in-hospital mortality of 27%. Four patients (patients 1–4) presented with rapidly progressive community-acquired pneumonia (CAP) and died within 48 hours of admission. Of these, three patients were not given initially appropriate empiric antibiotic therapy. The other causes of death included peritonitis (patients 7, 8), meningitis (patient 5), and empyema (patient 6).

The duration of follow-up of the 21 survivors after hospital discharge ranged from 3 to 32 months. Three patients had recurrent melioidosis and one patient died of a disease other than melioidosis. The relapse rate was 14%.

Discussion

The proportions of patients who were bacteremic were higher in Taiwan than in Southeast Asia and northern Australia. In the present study, 81% of cases were bacteremic, compared with 46% bacteremia in northern Australia,[15] 60% bacteremia in

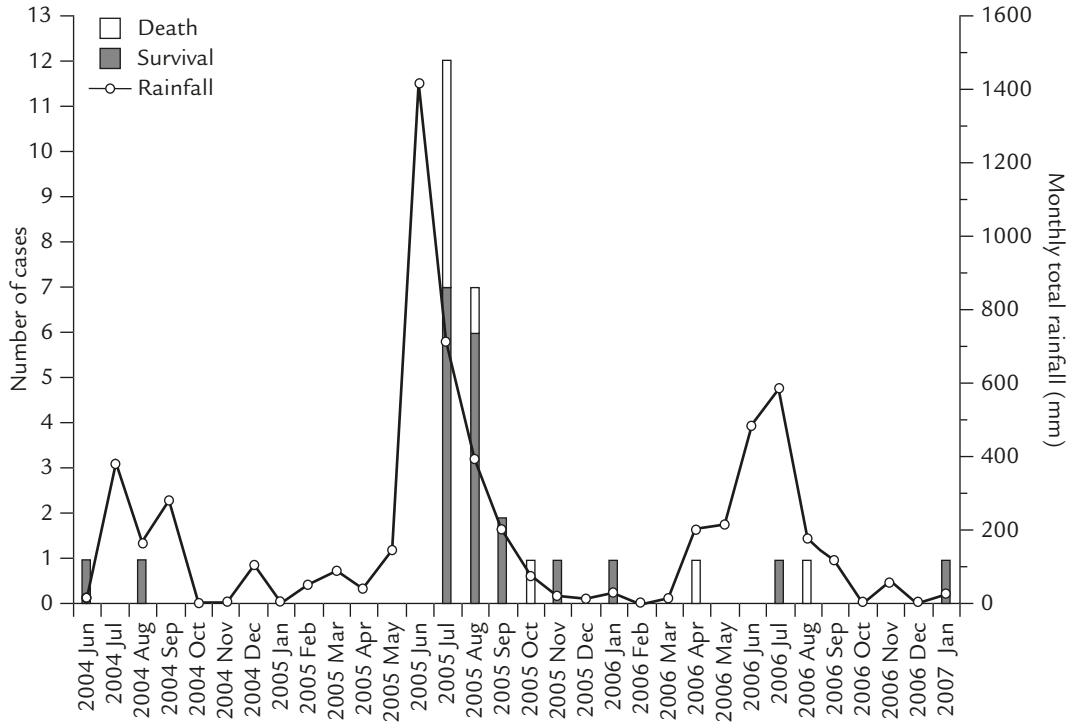

Figure 3. Seasonal distribution of cases of bacteremic melioidosis from June 2004 to January 2007.

Table 2. Characteristics of the nine non-survivors

Patient	Age/ Gender	Risk factors for melioidosis	Clinical manifestations	Hospital LOS (d)
1	50/F	None	Pneumonia, septic shock	<1
2	79/M	None	Pneumonia, septic shock	<1
3	68/M	DM	Pneumonia, septic shock	2
4	38/M	Excessive alcohol consumption	Pneumonia, septic shock	2
5	73/M	DM, chronic renal disease	Meningitis, pneumonia, septic shock	6
6	57/M	Lung cancer	Lung abscess, empyema, septic shock	47
7	75/M	DM, lung cancer	Peritonitis, pneumonia, septic shock	33
8	60/F	DM, HCC	Peritonitis, septic shock	12
9	48/F	DM	Dead on arrival	<1

DM = diabetes mellitus; HCC = hepatocellular carcinoma.

Thailand,[16] and 52% bacteremia in Singapore.[17] Although melioidosis can occur throughout life, our study documented that the disease only occurred in those 30 years of age and above, with a mean age of 65 years, in our case series. The male to female ratio was 2 to 1. Seventy percent were aged between 51 and 80 years. The patients in Taiwan tended to be older than in Singapore (mean age of 56 years).[18] Melioidosis presents mainly in the rainy season and occurs predominantly among rice farmers in northeastern Thailand.[19] In our study, most cases (70%) occurred in the post-typhoon outbreak and were not associated with rice farming.

Melioidosis is typically acquired by percutaneous inoculation during exposure to contaminated water. However, in our study, most (73%) of the affected individuals, including six patients (20%) who were completely bedridden, did not have a history of exposure to wet soil or

Table 3. Comparison of characteristics of patients with bacteremic melioidosis in Taiwan, Southeast Asia and northern Australia*

	Taiwan (this study)	Singapore[18]	Northeastern Thailand[19]	Malaysia[22]	Northern Australia[15]
Number of cases	30	30	63	50	117
Year of study	2004–2007	1997–2001	1986–1987	1976–1991	1989–1999
Presentation					
Pneumonia	70	60	23	58	56
Genitourinary tract infection	13	NA	8	10	20
Peritonitis	7	NA	NA	4	NA
CNS infection	3	NA	NA	6	NA
Skin or soft tissue infection	3	NA	13	24	NA
Mycotic aneurysm	3	NA	NA	NA	NA
No obvious focus	20	NA	51	NA	NA
Septic shock	43	NA	30	16	43
ICU admission	47	40	NA	NA	NA
Mortality	27	53	68	65	37

**Data are presented as % of patients. NA = not available; CNS = central nervous system; ICU = intensive care unit.*

contaminated water 1 week prior to the onset of symptoms. Inhalation, which is another route for acquisition of the bacterium, is a more plausible route in our patients, as the heavy rainfall could have exposed the soil-dwelling bacteria for subsequent aerosol dissemination in the strong typhoon winds. The association of melioidosis with the wet seasons has been postulated to be due to movement of *B. pseudomallei* from deeper soil layers to the surface with the rising water table.[20] Aerosolization of bacteria from soil and water under heavy winds and rainfall is probable, resulting in the potential for inhalation of *B. pseudomallei*.[21] Consistent with this suggestion, a shift to inhalation as the primary source of infection can occur during a typhoon.

The clinical presentations of bacteremic melioidosis in Taiwan differ from those in Southeast Asia and northern Australia. Table 3 summarizes the important clinical differences between patients with bacteremic melioidosis in Taiwan, Singapore,[18] northeastern Thailand,[19] Malaysia,[22] and northern Australia.[15] First, pneumonia is more common in Taiwan than in Southeast Asia and northern Australia. Pneumonia comprised 70% of cases in Taiwan, compared with 60% in Singapore, 23% in northeastern Thailand, 58% in Malaysia, and 56% in northern Australia. In the present study, 80% of our patients suffered from bacteremic melioidosis during the 3 months of the rainy season annually; of special note, 63% of cases occurred within 1 month after Typhoon Haitang. The number of cases of bacteremic melioidosis with pneumonia was significantly higher in this post-typhoon outbreak (OR, 34; 95% CI, 3.25–355.41; $p = 0.001$). The same condition was also noted at the top end of the Northern Territory of Australia; the intensity of rainfall was significantly correlated with pneumonia, bacteremia, septic shock, and death.[21]

Second, skin or soft tissue infection is less common in Taiwan than in Southeast Asia. Only 3% of cases had skin abscess in Taiwan, compared with 13% in northeastern Thailand, and 24% in Malaysia. In the present study, only one (3.3%) case was a rice farmer with soil exposure, while 73% of our cases did not have a history of exposure to wet soil or contaminated water 1 week prior to the onset of symptoms. This finding suggests that direct percutaneous inoculation of

B. pseudomallei after exposure to muddy soils or surface is uncommon in Taiwan.

Third, a higher proportion of patients with bacteremic melioidosis presented with septic shock in Taiwan than in Southeast Asia, but was similar to northern Australia. Septic shock occurred in 43% of cases in Taiwan, compared with 30% in northeastern Thailand, 16% in Malaysia, and 43% in northern Australia. In the present study, 63% of our cases occurred in the post-typhoon outbreak and 62% (8 of 13 patients) of septic shock developed in this period. Inhalation of a higher bacterial concentration in aerosols during heavy rainfall and wind than that delivered during an inoculation event was considered to be a cause of the increased severity. The same condition was found in northern Australia. The periods of heavy rainfall were associated with cases of increased severity and septic shock.[21] The above reasons may explain the higher proportion of septic shock observed in Taiwan and northern Australia.

Bacteremic melioidosis carries a high mortality risk in the absence of early and aggressive therapy.[15,18] In this study, 73% of our patients initially had appropriate empiric antibiotic therapy and the mortality rate was 27%. Thus, even though the patients displayed a higher proportion of septic shock, the early appropriate treatment regimen yielded lower mortality. In the present study, septic shock, acute renal failure, and respiratory failure were the major complications leading to mortality. Mortality in those with septic shock, acute renal failure, and respiratory failure were 69% (9 of 13 patients), 56% (9 of 16 patients), and 47% (9 of 19 patients), respectively. In a randomized controlled treatment trial in Thailand, bacteremia, respiratory failure, and renal failure were identified to be independently associated with death and treatment failure.[23] In a study of severe melioidosis in Singapore, the number of dysfunctional organs was an independent predictor of mortality.[24] In our study, most deaths (56%, 5 of 9 patients) occurred within 48 hours after admission. Mortality is high in severe melioidosis in which the clinical course deteriorates rapidly even with currently available treatment. The value of adjunctive treatment, such as granulocyte colony-stimulating factor, warrants further evaluation because of the limited data currently available. Optimal management of severe sepsis caused by melioidosis requires early goal-directed therapy,[25] lung-protective ventilation,[26] and early appropriate antibiotics.

In mid-July 2005, Typhoon Haitang caused heavy winds and rainfall with widespread flooding in southern Taiwan. Four patients were admitted to Tainan Municipal Hospital with ensuing pneumonia 1 week after Typhoon Haitang. Of these, one died within 10 hours of admission due to septic shock and multiorgan failure. Blood cultures collected from these patients on admission were positive for *B. pseudomallei*. These patients resided in regions that had experienced typhoon-related flooding. An outbreak of endemic melioidosis was highly suspected. For these reasons, the hospital's guidelines for the treatment of CAP from typhoon-affected flood areas were developed in Tainan Municipal Hospital. Typhoon-affected flood areas were regarded as endemic areas of melioidosis, including South District in Tainan City, Rende Township in Tainan County, and Jiading Township and Hunei Township in Kaohsiung County. Patients from the above areas received ceftazidime for admission to the general ward and meropenem for admission to the ICU until the pathogen was confirmed. These guidelines led to a higher proportion of appropriate empiric antibiotic therapy and reduced the mortality of bacteremic melioidosis. For the treatment of patients with CAP hospitalized on a general ward, the Infectious Diseases Society of America and the American Thoracic Society prefer a combination of a β-lactam plus a macrolide antibiotic or monotherapy with a fluoroquinolone antibiotic. Patients who require hospitalization in the ICU are treated with either a β-lactam plus either azithromycin or a fluoroquinolone antibiotic.[27] However, these agents are not active against *B. pseudomallei*. Therefore, locally adapted guidelines need to be developed for the treatment of CAP in endemic areas of melioidosis and after extreme weather events such

as typhoons or heavy rains in southern Taiwan. Early and effective treatment will aid in the reduction of mortality. The same condition was found in tropical northern Australia, where melioidosis has been a significant cause of mortality, and where treatment guidelines for CAP based on epidemiology have been developed.[28]

Our study suggests that firstly, the lungs are the most common site of infection with bacteremic melioidosis and rapidly progressive CAP is the major cause of mortality. Secondly, most deaths occurred within 48 hours after presentation to hospital. Patients with septic shock, acute renal failure, and respiratory failure have significantly higher mortality. Thirdly, typhoon Haitang was associated not only with higher numbers of cases and deaths but also with pneumonic presentations. Melioidosis should be considered in the differential diagnosis of any patient with rapidly progressive CAP in southern Taiwan, especially in the aftermath of a typhoon. Fourthly, locally adapted guidelines should be developed for the treatment of CAP from endemic areas of melioidosis and after extreme weather events such as typhoons or heavy rains in southern Taiwan.

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